

APPENDIX E
BOP SYSTEM AND EQUIPMENT DEFINITIONS

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<p>Surface Control System The purpose of the BOP control system is to provide a means to individually actuate components in the BOP stack by providing pressurized hydraulic fluid to the selected stack components.</p> <p>Consists of Electric Power Supply, UPS, HPU, Human to Machine Interface (HMI), MCC and I/O modules to process, communicate and display command and status data.</p>	
<p>Hydraulic Power Unit (HPU)</p>	<p>Monitors, mixes, stores hydraulic fluid and generates pressurized hydraulic fluid for BOP system control usage. Directs the hydraulic fluid via regulators and manifolds to various BOP functions and surface accumulators.</p> <p>Mixing system Storage tanks, pumps and associated pipes & manifolds to mix storage tank contents with a fresh water supply and store in a mixing tank with level indicators and mixing pumps.</p> <p>Hydraulic Power Unit Creates and monitors hydraulic operating pressure inclusive of distribution piping, hydraulic pumps with associated electric motors, suction strainers, high pressure discharge filters, check and isolation valves in discharge manifold, hydraulic manifolds supplying accumulator banks, rigid conduit and hose reels inclusive of isolation & relief valves.</p>
<p>Electrical Power</p>	<p>Uninterruptible power supply (UPS), blue & yellow UPS, inclusive of independent control and distribution, battery - charged from primary generators or emergency generator, power distribution panels, power isolation junction box (J-box) providing isolation and/or cross-feed of UPS output, distribution panel distributing power to the various MUX control systems, umbilical J-box providing control voltage to subsea functions.</p>
<p>MUX Control System</p>	<p>Subsea multiplex system (MUX) BOP control systems provide electrical power, control signal, hydraulic power and communication to various BOP functions.</p> <p>Central Command Center/Unit (CCC/CCU) The primary processor to interpret and communicate control functions to and from subsea control pods by means of:</p> <ul style="list-style-type: none"> – Processing array for communication and distribution – Power distribution and communication to associated equipment – Flash drives: pre-programmed hard disk drives with processing software programmed by the OEM – Climate-controlled purged cabinets. <p>MUX Reels: Spools for mux cable inclusive of; drive motors, level winds, brakes and control panels. The MUX electrical cable supplies power and communications for control of the subsea control pods. The MUX cable is run, retrieved, and stored on a cable reel.</p> <p>Slip Rings: Fiber optic and electrical to provide communication during rotation.</p>

<p>Surface Control System The purpose of the BOP control system is to provide a means to individually actuate components in the BOP stack by providing pressurized hydraulic fluid to the selected stack components.</p> <p>Consists of Electric Power Supply, UPS, HPU, Human to Machine Interface (HMI), MCC and I/O modules to process, communicate and display command and status data.</p>	
Rigid Conduit & Hotline	<p>Provide path for transfer of hydraulic fluid for subsea operations.</p> <p>Pipes, tubes and/or flexible hoses (hotline, hydraulic hose, rigid piping and tubing) The hotline hose supplies power fluid from the surface to the subsea control pods mounted on the LMRP. The hotline is run, retrieved, and stored on the hose reel.</p> <p>Hydraulic Supply Line (Hard/Rigid Conduit) An auxiliary hydraulic supply line, referred to as a hard or rigid conduit, is a line attached to riser joints. The purpose of this auxiliary line is to supply control fluid from the surface accumulator system to the control pods and subsea accumulators mounted on the BOP and/or LMRP assemblies.</p> <p>Reels: Spools for hydraulic hoses inclusive of; drive motors, level winds, brakes and control panels.</p> <p>Swivel: Provides hydraulic communication between supply and hose on the reel during rotation.</p>
Surface Accumulators	Pressure vessel to store hydraulic energy with internal pressurized bladder (bag), charging valve, manifold and racks to mount and segregate multiple bottles, isolation valves, relief valves and check valves.
Control Panels	<p>Control station/panel, remote A panel containing a series of controls that will operate the BOP functions from a location that is remote from the hydraulic control manifold or central processor in the case of a MUX or multiplex control system. Remote panels sending and receiving command and status signals to/from the CCC/CCU, inclusive of:</p> <ul style="list-style-type: none"> – HMI: to input command signals (button or touch-screen) – Monitors – Indicator to display data – Processor nodes and/or cards – Flash drives (software programmed by OEM) – Sensors and alarms for control system & BOP status – Cabinet purge system with sensors and alarms – Includes TCP (Toolpusher Control Panel), DCP (Driller Control Panel)), Hydraulic control panel and local panels.

Subsea Control System

Primarily located subsea on the LMRP, it receives hydraulic fluid and command signals from the HPU and CCC/CCU respectively to regulate and direct hydraulic fluid to designated control and function-operators. Provide interface with Emergency and Secondary Control System commands.

Blue & Yellow Subsea Control System

Control pod

An assembly of valves and regulators (either hydraulically or electrically operated) that when activated will direct hydraulic fluid through special apertures to operate the BOP equipment. Each control pod contains SEM Module, all necessary valves and regulators to operate the BOP stack and LMRP functions. Blue & Yellow pods, located on the Lower Marine Riser Pack (LMRP) to receive command signals and hydraulic fluid and convert it to regulated hydraulic signal. Also communicates status signals to and from CCC/CCU. The system includes the following components:

- **Subsea Electronic Module (SEM):** electronic modules to convert fiber-optic signal for input to solenoid valves and provide power distribution
- **Compensated Chamber:** sealed di-electric fluid filled chamber containing electronic components compensated to outside hydrostatic pressure
 - **Solenoid valves:** receive electrical signal to operate SPM valves. (DDV's (Direct Drive Valve (solenoid valve)) and CCSV's (Compensated Chamber Solenoid Valve))
- **SPM Valves:** three (3) way spool valves operated by a hydraulic pilot signal
- **Hydraulic Manifold:** manifold block in which SPM valves are mounted. Provides supply pressure as well as, ambient vent and operate port for each valve
- **Pilot Operated Valves (POCV) and (SSV) :** Pilot-operated directional valves
- **Manual Pressure Regulator:** a component that permits attenuation of control system supply pressure to a satisfactory pressure level to operate components downstream and is manually adjustable
- **Remote Pressure Regulator:** a component that permits attenuation of control system supply pressure to a satisfactory pressure level to operate components downstream and adjustable remotely using pilot hydraulic supply
- **Pilot and Supply Manifold Filters** A device to entrap physical contaminants of particular size in hydraulic fluid before it goes into system downstream
- **Tubing:** pipes and tubes to direct hydraulic fluid to its designated operator function
- **Shuttle Valves:** Two-position three-way valves installed on operating ports of Stack components. They provide communication between Yellow or Blue Control Pods and the associated equipment.
- **Flexible hoses:** steel braided rubber hose between pods and shuttle valves and end device
- **Pod Receptacles:** pod interface to LMRP and BOP receiver inclusive of packer seals seal subs and locks
- **Pod Flow meters:** A device/component to measure fluid volume on blue & yellow pods
- **MUX subsea**

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LMRP-mounted Accumulators	LMRP-mounted, accumulators associated with specific functions
Emergency & Secondary Controls	<p>Emergency control systems operated either automatically or by surface command; and Secondary control systems such as acoustic signal or via Remote Operated Vehicle (ROV) intervention.</p> <ul style="list-style-type: none"> • Emergency Disconnect System (EDS): The EDS is a programmed sequence of events that operates the functions to leave the stack and controls in a desired state and disconnect the LMRP from the lower stack. The number of sequences, timing, and functions of the EDS are specific to the rig, equipment, and location. • Autoshear: Autoshear is a safety system that is designed to automatically shut-in the wellbore in the event of a disconnect of the LMRP • Deadman: The deadman system is designed to automatically shut in the wellbore in the event of a simultaneous absence of hydraulic supply and control from both subsea control pods. • Acoustic Control: The acoustic control system is an optional secondary control system designed to operate designated BOP stack and LMRP functions and may be used when the primary control system is inoperable. • ROV Operation: the provision for ROV intervention to operate critical functions on the subsea BOP stack. ROV intervention equipment that, at a minimum, allows the operation of the critical functions (each shear ram, one pipe ram, ram locks, and unlatching of the LMRP connector).

Subsea BOP Stack

The complete assembly of subsea well control equipment, including various preventers, spools, valves, connectors and nipples connected to the top of the wellhead or wellhead assemblies. The BOP Stack is to contain wellbore fluids either in the annular space between the casing and the tubulars, or in an open hole during well drilling, completion, and testing operations.

Annulars	A blowout preventer that uses a shaped elastomeric sealing element to seal the space between the tubular and the wellbore or an open hole.
Blind Shear Ram	Ram BOP whose ram blocks incorporate a cutting blade to shear the pipe and sealing elements to contain wellbore pressure upon shearing of the pipe. A closing and sealing component in a ram blowout preventer that first shears certain tubulars in the wellbore and then seals off the bore or acts as a blind ram if there is no tubular in the wellbore.
Casing Shear Ram	Ram BOP whose ram blocks incorporate a cutting blade to cut casing and/or heavier grade tubulars within a specific range. They do not seal the well bore. A closing component in a ram blowout preventer that is capable of shearing or cutting certain tubulars.
Pipe & Test Rams	<ul style="list-style-type: none">• Pipe ram: A closing and sealing component in a ram blowout preventer that seals around the outside diameter of a tubular in the wellbore• Ram blowout preventer: a blowout preventer that uses metal blocks with integral elastomer seals to seal off pressure on a wellbore with or without tubulars in the bore• Fixed Pipe Ram: closing and sealing component in a ram blowout preventer that is capable of sealing on a fixed tubular size• Variable Pipe Ram: closing and sealing component in a ram blowout preventer that is capable of sealing on a range of tubular sizes• Test Ram: A Variable Bore Ram located in the lower most ram cavity with ram block installed in an inverted position to seal pressure from the top and enable testing of the BOP Stack without running a test tool.

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Choke & Kill Valves and Lines

Valves and pipes assembly enabling communication to or from the well bore to the surface C&K manifold to circulate well, control kicks or kill a well.

- **Choke/Kill Line:** a high-pressure line that allows fluids to be pumped into or removed from the well with the BOPs closed
- **Subsea Choke and Kill Valves:** fail-safe gate valves enabling communication with the well bore.
- **Bleed Valves:** fail-safe Valves located under the Upper most Annular to relieve trapped pressure/gas from the BOP stack upon completion of well control operations.
- **Choke and Kill Line Test Valves:** fail-safe valves enabling test of the Choke and Kill Lines while running the BOP stack or LMRP
- **Flanges and Spools:** devices incorporated in the Choke and Kill piping system, consists of spools (pipe with flanged connections), T-, L- and/or Y-blocks (machined blocks providing fluid communication between three flanges or ports and target and blind flanges used to close a flanged outlet of a BOP or redundant port of a three-way block
- **Spacer Spool:** a spool used to provide separation between two components with equal sized end connections
- **Flex Loop & Jumper Hoses:** pipe or hoses installed between C&K stabs of the LMRP and the fixed C&K connection to the riser to accommodate displacement of the flex joint
- **Drape Hoses:** provide communication form C&K Stabs on the slip joint outer barrel and rigid pipe of the surface C&K System. They accommodate vertical and angular displacement of the rig

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Connectors

- **Hydraulic connector:** hydraulically actuated equipment that locks and seals on end connections and provides a mechanical and/or hydraulic path
- **LMRP Connector:** connects the LMRP to the BOP stack
- **Well Head Connector:** connects the BOP stack to the well head
- **Choke and Kill Stabs:** connects C&K Lines between LMRP and BOP stack
- **Conduit and Hotline Hydraulic Stabs:** connectors coupling surface hydraulic fluid to the LMRP and/or Control Pods (pod connector)
- **Wetmate Connector:** offer wet make-up of electrical interfaces in subsea power systems
- **HPHT Sensors:** High Pressure/High Temperature Sensors to detect and transmit pressure and temperature of well bore fluids at the well head.
- **ERA Sensors:** Electronic Riser Angle Sensors to detect and communicate riser angle offset.

Stack-mounted Accumulators (Autoshear)

Stack-mounted accumulator dedicated to provide hydraulic energy (volume and pressure) for emergency operation of casing shear rams and blind shear rams.

Accumulator: a pressure vessel to store hydraulic energy charged with inert gas and used to store hydraulic fluid under pressure.